Brian Munsky

Center for Nonlinear Studies, Mail-stop B258
Los Alamos National Laboratory; Los Alamos, NM 87545
◇Phone [505-665-6691], ◇Fax [505-665-2659], ◇E-mail [munsky@lanl.gov]
◇Website: [http://cnls.lanl.gov/~munsky]

◇ Education

- ◇ **The University of California at Santa Barbara (UCSB)**
  Ph.D. in Mechanical Engineering (2008); Advisor: Mustafa Khammash
  Dissertation topic: *Modeling and Analysis of Stochastic Networks in Biological Systems.*
- ◇ **The Pennsylvania State University (PSU)**
  M.S. in Aerospace Engineering (2002), Advisor: Farhan Gandhi
  Thesis topic: *Fluid/Structural/Acoustic Analyses of Helicopter Blade-Vortex Interactions.*
- ◇ **The Pennsylvania State University (PSU)**
  B.S. in Aerospace Engineering (2000), Advisors: Farhan S. Gandhi and Edward C. Smith
  Honors thesis topic: *Active/Passive Damping Treatments to Alleviate Resonant Oscillations.*

Highlight–*My discovery of the* Finite State Projection method *won the* **2007-2008 USCB Department of Mechanical Engineering Best Ph. D. Dissertation Award** *and led to several publications, which have been cumulatively cited over 250 times worldwide since 2006 (software available online).*

◇ Research Experience (details/publications on pages 2-4)

- ◇ **Richard P. Feynman Distinguished Postdoctoral Fellow**, Center for Nonlinear Studies (CNLS), Los Alamos National Laboratory (06/2008-Present).
- ◇ **Chancellor's Graduate Research Fellow**, Mechanical Engineering, UCSB (09/2003-06/2008).
- ◇ **Graduate Research Fellow**, Aerospace Engineering, PSU (05/2000-09/2002).
- ◇ **Undergraduate Research Assistant**, Aerospace Engineering, PSU (01/1999-05/2000).

Highlight–*I have a strong publication record of two book chapters and over 25 peer-reviewed articles (18 as first author), including high impact articles in* **Science** *(2012) and* **Molecular Systems Biology** *(2009).*

◇ Teaching and Mentoring Experience (details on pages 4-5)

- ◇ **Summer School Organizer and Lecturer**, Los Alamos National Laboratory (06/2008-present).
- ◇ **Postdoc Sponsor and Mentor**, Los Alamos National Laboratory (05/2011-present).
- ◇ **Course Development and Teaching**, Dept. of Mechanical Engineering, UCSB (Spring, 2007).
- ◇ **Graduate Teaching Assistant**, Dept. of of Aerospace Engineering, PSU (Spring, 2001).
- ◇ **Writing Tutor**, University Learning Resource Center, PSU, (01/1997-12/1997).

Highlight–**As lead organizer of the 2011 and 2012 q-bio Summer Schools**, *I helped increase applications from 40 qualified applicants in 2010 to over 180 qualified applicants in 2012. I also helped organize four successful international conferences in quantitative biology, including the 2011 and 2012 q-bio Conferences.*

◇ Selected Honors and Awards (see also page 5)

- ◇ 2011 NSF/I2CAM Workshop Support Award ($25,000 in support)
- ◇ 2009-2010 Leon Heller Postdoctoral Publication Prize at the Los Alamos National Laboratory
- ◇ 2010-2013 Richard P. Feynman Postdoctoral Fellowship at the LANL
- ◇ 2008 Best Ph. D. Dissertation Award–UCSB Department of Mechanical Engineering
- ◇ 2003-3008 UCSB Chancellor's Graduate Research Fellowship
- ◇ 2001-2002 National Defense Science and Engineering Graduate (NDSEG) Fellowship

◇ Research Experience Details

- ◇ **Richard P. Feynman Postdoctoral Fellow**, Center for Nonlinear Studies (CNLS), Information Sciences (CCS-3) and Advanced Measurement Sciences (B-9), Los Alamos National Laboratory
  As an independent postdoctoral fellow, I have initiated numerous multidisciplinary collaborations with engineers, physicists, and experimental biologists. My focus is to integrate discrete stochastic models with single-cell and single-molecule experiments in order to improve predictive understanding of biological behaviors in bacteria, yeast, algae and mammalian cells (Jul. 2008 to Present).
- ◇ **Graduate Research Fellow**, Mechanical Engineering, UC-Santa Barbara.
  I developed the Finite State Projection approach for the analysis of single-cell gene regulation dynamics. Working closely with experimental biologists, I used this approach to identify and validate a stochastic model of the Pap Pili epigenetic switch in *E. coli* (Aug. 2003 to Jun. 2008).
- ◇ **Graduate Research Fellow**, Aerospace Engineering, Penn State University.
  I developed a Finite Element aeroelastic model to simulate the effects of helicopter flight trajectories on the noise due to Blade-Vortex Interactions (May 2000–Aug. 2002).
- ◇ **Undergraduate Research Assistant**, Aerospace Engineering, Penn State University.
  I used Finite Element Analysis to optimize the design and control of piezoelectric and viscoelastic materials to alleviate resonant oscillations. I also helped analyze, design, and build a piezoelectric actuator for rotor blade trailing edge flaps (Jan. 1999–May. 2000).

◇ Peer-Reviewed Journal Articles

Download full papers at: `http://cnls.lanl.gov/~munsky`

27) B. Munsky*, G. Neuert*, A. van Oudenaarden, Using Gene Expression Noise to Understand Gene Regulation, *Science*, **336**:6078, 183-187, Apr. 2012. *Contributed Equally.

26) B. Munsky and M. Khammash, Identification from stochastic cell-to-cell variation: A genetic switch case study, *IET Systems Biology*, **4**:6, 356-366, Nov. 2010.

25) G. Bel*, B. Munsky*, and I. Nemenman, Simplicity of Completion Time Distributions for Common Complex Biochemical Processes, *Physical Biology*, **7**:016003, Mar. 2010. *Contributed Equally. **Most read article of 2010 at *Physical Biology*. Reviewed at *sciencedaily.com, biology-online.org, PhysOrg.com* and many others.**

24) B. Munsky*, I. Nemenman, and G. Bel*, Specificity and Completion Time Distributions of Biochemical Processes, *J. of Chemical Physics*, **131**:235103, Dec. 2009. *Contributed Equally.

23) B. Munsky, B. Trinh and M. Khammash, Listening to the Noise: Random Fluctuations Reveal Gene Network Parameters, *Molecular Systems Biology*, **5**:318, Oct. 2009. **Faculty of 1000 Biology Must Read and awarded the 2010 Leon Heller Postdoctoral Publication Prize.**

22) B. Munsky and M. Khammash, Transient Analysis of Stochastic Switches and Trajectories with Applications to Gene Regulatory Networks, *IET Systems Biology*, **2**:5, 323-333, Sept. 2008.

21) B. Munsky and M. Khammash, The FSP Approach for the Analysis of Stochastic Noise in Gene Networks, *IEEE Trans. Automat. Contr./IEEE Trans. Circuits and Systems: Part 1*, **52**:1, 201-214, Jan. 2008.

20) B. Munsky and M. Khammash, A Multiple Time Interval Finite State Projection Algorithm for the Solution to the Chemical Master Equation, *J. Comp. Phys.*, **226**:1, 818-835, Sept. 2007.

19) B. Munsky and M. Khammash, Analysis of Noise Induced Stochastic Fluctuations in Gene Regulatory Networks, *J. SICE*, **46**:5, 405-411, May 2007.

18) S. Peleš*, B. Munsky* and M. Khammash, Reduction and Solution of the Chemical Master Equation Using Time Scale Separation and Finite State Projection, *J. of Chemical Physics*, **125**:204104, Nov. 2006. *Contributed Equally.

17) B. Munsky and M. Khammash, The Finite State Projection Algorithm for the Solution of the Chemical Master Equation, *J. of Chemical Physics*, **124**:044104, Jan. 2006.

16) B. Munsky, F. Gandhi and L. Tauszig, Analysis of Helicopter Blade-Vortex Interaction Noise with Flight Path or Attitude Modification, *J. American Helicopter Society*, **50**:2, 123-137, Apr. 2005.

15) F. Gandhi and B. Munsky, Effectiveness of Active Constrained Layer Damping Treatments in Attenuating Resonant Oscillations, *J. of Vibration and Controls*, **8**:6, 747-775, 2002.

14) F. Gandhi and B. Munsky, Comparison of Damping Augmentation Mechanisms with Position and Velocity Feedback in Active Constrained Layer Treatments, *J. of Intelligent Material Systems and Structures*, **13**:5, 259-326, May 2002.

13) L. Centolanza, E. Smith and B. Munsky, Design, Fabrication, and Experimental Testing of an Induced-Shear Piezoelectric Actuator for Rotor Blade Trailing Edge Flaps, *Smart Materials and Structures*, **11**, 24-35, Feb. 2002.

◇ Peer-Reviewed Conference Papers

12) D. Shepherd, N. Li, E. Hong-Geller, B. Munsky, and J. Werner, New tools for discovering the role sRNA plays in cellular regulation, *Proc. SPIE* 8228:822808, San Francisco, CA, Jan. 2012.

11) B. Munsky and M. Khammash, Using Noise Transmission Properties to Identify Stochastic Gene Regulatory Networks, *Invited Paper: Proc. of the* 47^{th} *IEEE Conference on Decision and Control*, Cancun, Mexico, Dec. 2008.

10) B. Munsky and M. Khammash, Computation of Switch Time Distributions in Stochastic Gene Regulatory Networks, *Invited Paper–Proc. of the* 27^{th} *American Control Conference*, Seattle, WA, Jun. 2008. **Best Presentation Award.**

9) P. Inglesias, M. Khammash, B. Munsky, E. Sontag and D. Del Vecchio, Systems Biology and Control – A Tutorial, 46^{th} *IEEE Conference on Decision and Control*, New Orleans, LA, Dec. 2007.

8) M. Khammash* and B. Munsky*, Systems Theory Applications in Biology: From Stochastic Chemical Kinetics to Deterministic Model Invalidation, *Invited Paper–Proc. of the European Control Conference*, Kos, Greece, Jul. 2007.*Contributed Equally.

7) B. Munsky, S. Peleš and M. Khammash, M., Stochastic Analysis of Gene Regulatory Networks Using Finite State Projection and Singular Perturbation, *Invited Paper–Proc. of the* 26^{th} *American Control Conference*, 1323-1328, New York, NY, Jul. 2007.

6) B. Munsky and M. Khammash, A Reduced Model Solution for the Chemical Master Equation Arising in Stochastic Analyses of Biological Networks, *Proc. of the* 45^{th} *IEEE Conference on Decision and Control*, 25-30, San Diego, CA, Dec. 2006.

5) B. Munsky and M. Khammash, Modeling and Analysis of a Bacterial Stochastic Switch, *Proc. of the* 14^{th} *Mediterranean Conference on Control and Automation*, Ancona, Italy, Jun. 2006.

4) B. Munsky, A. Hernday, D. Low, and M. Khammash, Stochastic Modeling of the Pap Pili Epigenetic Switch, *Proc. of Foundations of Systems Biology in Engineering*, 145-148, Santa Barbara, CA, Aug. 2005.

3) B. Munsky, F. Gandhi and L. Tauszig, *Proc. of the 58th Annual Forum of the AHS, Acoustic Session*, **2**, 1531-1551, Montreal, Canada, Jun. 2002.

2) B. Munsky and F. Gandhi, *Proc. of the AIAA/ ASME/ ACSE/ AHS/ ASC Structures, Structural Dynamics, and Materials Conference*, Seattle, Washington, Apr. 2001.

1) F. Gandhi and B. Munsky, *Proc. of SPIE Smart Structures and Materials*, **3989**, Orange County, CA, pp. 61-72, Mar. 2000.

◇ Book Chapters

◇ B. Munsky, Modeling Cellular Variability, in *Quantitative Biology From Molecular to Cellular Systems*, M. Wall, Ed., Taylor & Francis Group, New York, NY, 2012 (in press).

◇ M. Khammash* and B. Munsky*, Stochastic Gene Expression: Modeling, Analysis, and Identification, in B. Levine, *The Control Handbook, Second Edition*, Taylor & Francis Group, New York, NY, 2010.

◇ Manuscripts Pending Review

- G. Neuert*, B. Munsky*, R. Tan, M. Khammash, A. van Oudenaarden, Systematic Identification of Signal-Activated Stochastic Gene Regulation, In Revision, 2012. *Contributed Equally.
- C. Lou, B. Munsky, C. A. Voigt, Insulator Parts to Buffer Synthetic Circuits from Genetic Context, In Revision, 2012.
- J. Tapia, J. Faeder, B. Munsky, Adaptive Coarse-Graining for Transient and Quasi-Equilibrium Analyses of Stochastic Gene Regulation, *Submitted to* 51^{st} *IEEE Conference on Decision and Control*, 2012.*Contributed Equally.

◇ Teaching and Tutoring Experience

- **Summer School Organizer and Lecturer**, Los Alamos National Laboratory.
  For the q-bio Summer School (2009-2012), I have designed syllabi and taught courses; I recruited both students and senior lecturers; and I raised and awarded scholarship funding. As the main organizer for the last three years, I increased applications from 37 in 2010 to over 180 in 2012; I assisted UCSD to create a second branch campus for the summer school; and I arranged an experimental component to the 2012 summer school. *Student feedback forms available upon request.*
- **Mentoring**, Los Alamos National Laboratory.
  Since 2011, I co-sponsored and co-funded an experimental/computational postdoc (Dr. Douglas Shepherd) to work on the measurement and analysis of single mRNA molecules in mammalian cells.
  In 2010, I mentored two graduate summer students and a postdoc in work on the analysis and identification of stochastic models for bacterial gene regulatory mechanisms.
- **Course Development and Teaching**, Department of Mechanical Engineering, UC-Santa Barbara.
  Together with Mustafa Khammash, I co-developed and co-taught a new graduate level course on the modeling and analysis of stochastic gene regulatory networks. Duties included researching material, preparing and giving lectures, and assigning and grading homework and exams (Spring, 2007).
- **Graduate Teaching Assistant**, Department of of Aerospace Engineering, Penn State University.
  For a course on the numerical analysis of structures, I prepared and delivered review sessions; assigned, solved, and graded homework assignments; and provided tutoring to students (Spring, 2001).
- **Writing Tutor**, University Learning Resource Center, Penn State University.
  As a trained peer tutor for writing, I assisted undergraduate, graduate and ESL (English as a Second Language) students at the Penn State Writing Center (Jan.–Dec. 1997).

◇ Tutorials and Lectures

- B. Munsky, Analyzing and Identifying Stochastic Models Using Flow Cytometry and Fluorescence Microscopy, *The* 4^{th} *q-Bio Conference on Cellular Information Processing*, Santa Fe, NM, Jul.-Aug. 2010. (Updated and presented with Gregor Neuert at the *The* 5^{th} *q-bio Conference*, Santa Fe, NM, Aug. 2012.)
- B. Munsky, Stochastic effects in systems biology: Theoretical Foundations and Experimental Results, Part I and II, The 2^{nd} *q-Bio Summer School on Cellular Information Processing*, Los Alamos, NM, Jul.-Aug. 2008 (Also updated and presented at *The* 3^{rd} *q-Bio Summer School on Cellular Information Processing*, Los Alamos, NM, Jul.-Aug. 2009).
- B. Munsky and M. Khammash, Stochastic Gene Expression in Systems Biology, *The* 2^{nd} *q-Bio Conference on Cellular Information Processing*, Santa Fe, NM, Aug. 6, 2008.
- M. Khammash and B. Munsky, Stochastic Gene Expression in Systems Biology, *The* 8^{th} *International Conference on Systems Biology*, Long Beach, CA, Oct. 2007.

◇ Selected and Invited Talks

- Using spatial and temporal fluctuations to identify predictive quantitative models of gene regulatory pathways, *Design, optimization and control in systems and synthetic biology*, Paris, France, June, 2012.

- Identification of Gene Regulation Mechanisms and Parameters, *Workshop on Stochastic Systems Biology*, Monte Verita, Switzerland, July, 2011.
- Listening to the Noise: Random Fluctuations Reveal Gene Network Parameters, *Invited Talk, UC-San Francisco*, San Francisco, CA, Dec. 1, 2009 (Also presented at *UC-Berkeley* on Nov. 30, 2009, *Stanford* on Dec. 3, 2009, *MIT* on Jan. 28, 2010, the *Santa Fe Complex* on Apr. 7, 2010, and the *University of Washington* on May 13, 2010).
- Stochastic model validation for the Pap (pili) epigenetic switch, *Selected Talk: The* 3^{rd} *q-Bio Conference on Cellular Information Processing*, Santa Fe, NM, Aug. 9, 2009.
- Listening to the Noise: Random Fluctuations Reveal Gene Network Parameters, *Selected Talk: The* 3^{rd} *q-Bio Conference on Cellular Information Processing*, Santa Fe, NM, Aug. 8, 2009.
- Analyzing Stochastic Switches and Trajectories in Gene Regulatory Networks, *Invited Talk, University of Pittsburgh*, Pittsburgh, PA, Mar. 20, 2009.
- Sensitivity Analysis and Parameter Identification of Stochastic Gene Regulatory Networks using Finite State Projection Techniques, *Selected Talk: The Eighth International Conference on Systems Biology*, Long Beach, CA, Oct. 2008.
- Finite State Projection Solutions to the CME Arising in Gene Regulatory Networks, *Selected Talk: The* 1^{st} *q-Bio Conference on Cellular Information Processing*, Santa Fe, NM, Aug. 2007.

◇ Honors and Awards (see also page 1)

- 2010 SIAM Conference in the Life Sciences (LS10) Poster Award
- Best Presentation in Session, 27^{th} American Controls Conference in Seattle, WA, (June 2008)
- American Controls Conference Student Travel Award (2007, 2008)
- University of California Student Travel Grant (2007)
- NSF Graduate Fellowship Honorable Mention (2001)
- Penn State Schreyer Ambassador Travel Grant (1999)
- American Helicopter Society Vertical Flight Foundation Award (Twice: 1999, 2000)
- Mary Ilgen Memorial Scholarship (1999–2000)
- Graduated with Honors from the Penn State Schreyer Honors College (May 2000)
- Penn State Deans List (7 times)

◇ Fellowships and Research Support

- DOE/LANL/LDRD: "Illuminating the Dark Matter of the Genome: Small RNAs as Novel Targets for Bioterrorism Countermeasures", Oct. 2010–Oct. 2013, co-investigator.
- Richard P. Feynman Distinguished Postdoctoral Fellowship at LANL (March 2008–March 2013)
- Director's Postdoctoral Fellowship at LANL (July 2008–March 2010)
- UCSB Chancellor's Graduate Research Fellowship (Sep. 2003–May 2008)
- UCSB Department of Mechanical Engineering Graduate Fellowship (Sep. 2003–May 2008)
- National Defense Science and Engineering Graduate (NDSEG) Fellowship (2001–2002)
- Penn State University College of Engineering Graduate Fellowship (2000–2001)

◇ Professional Activities

- Co-Proposer for a special session on Stochastic Analysis and Inference of Biochemical Processes at the 51^{st} *IEEE Conference on Decision and Control*, Maui, HI, Dec. 2012.
- Co-Organizer for a tutorial workshop on Identification, Analysis and Design of Biological Networks at the 51^{st} *IEEE Conference on Decision and Control*, Maui, HI, Dec. 2012.
- Co-Organizer for 5^{th} and 6^{th} *q-bio Conferences* (Santa Fe, New Mexico, August 2011 and 2012).

- Main organizer and Stochastic Gene Regulation Theme Leader for the 4^{th}-6^{th} *q-bio Summer Schools in Cellular Information Processing* (Los Alamos and Santa Fe, NM, 2010, 2011, 2012).
- Co-Organizer of *The* 3^{rd} *Workshop on Stochasticity in Biochemical Reaction Networks* at the Banff International Research Station (BIRS) in Banff, Canada, Sept. 11-16, 2011. **Registration, lodging and meals paid for all 42 participants through competitive BIRS grant. Airfare paid for junior researchers through a competitive ICAM grant**.
- Co-Organizer of *The* 2^{nd} *Workshop on Stochasticity in Biochemical Reaction Networks* at BIRS in Banff, Canada on Sep. 25-27, 2009. **Registration, lodging and meals paid for all 25 participants through competitive BIRS grant**.
- Co-Organizer of *The 2009-10 Center for NonLinear Studies q-bio Seminar Series*, Los Alamos National Laboratory. Duties include choosing, inviting, scheduling and arranging funding for external visitors.
- Referee for *Science Signaling*, *Physical Biology*, *Automatica*, *Physics Review Letters, Journal of Physics A: Mathematical and Theoretical*, *Physics Letters A*, *The IEEE Conference on Decision and Control*, *The IEEE American Controls Conference*, *The IFAC Symposium on System Identification*, *IET Systems Biology*, *Biotechnology Progress*, *PLoS Computational Biology*, and *Smart Materials and Structures*.
- Past or current member of the Institute of Electrical and Electronics Engineers (IEEE), American Physical Society (APS), the American Association for the Advancement of Science (AAAS), the Society for Industrial and Applied Mathematics (SIAM), and the International Society for the Advancement of Cytometry (ISAC).

Skills

- **S**ystems and Control theory based modeling and analysis techniques for biological systems. These include tools for sensitivity and robustness analysis, model reduction, and parameter identification for complex bio-networks.
- **N**umerical methods for stochastic systems: stochastic simulations, τ leaping, hybrid methods, Stochastic Differential Equations, Finite State Projection reductions for master equations, and others.
- **N**umerical analyses of PDEs using finite difference, finite element, Raleigh-Ritz, and other approaches.
- **C**/C++, Fortran, Matlab, Unix, Linux, MS-Windows, Mac OS X, LaTeX, Maple, Mathematica and others.

Software

- FSP Toolkit for analyzing discrete stochastic proceses.*
- FSP FitTools for identifying stochastic models from single cell flow cytometry measurements.*

*Available upon request.

References

- Available upon request.